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FINAL TECHNICAL REPORT

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under U.S. Navy contract Nonr -(G) - 0001 - 60







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Introduction

This report concerns the work accomplished under contract Nonr (G) - 0001 - 60. The preliminary phase of our investigation, published in "Notes et informations de l'Observatoire de Paris", fascicule 1, no.1, is resumed in part I of this report. The rest of our work, which is to be published shortly in the same review, is described in detail in part II.

## I Identifications and wavelengths (1)

The preliminary phase of our investigation included essentially two points:

1. the identification of lines observed as a function of time in the spectra

2. the accurate determination of their wavelengths by means of the comparison spectra

The results of this work, tabulated in a previous publication, indicate qualitatively the evolution of each line, as a function of wavelength, with the time. These measurements reveal also the existence of certain spectral particularities, such as the juxtaposition of two sharp Ca II and K lines, which seems to indicate the presence of lines originating in the interstellar medium as well as in the cloud surrounding the star.

(1) This work has been accomplished under the direction of J.C. Pecker and S.R. Pottasch by J. Rountree-Lesh and B. Folkart

## II Early Balmer lines: detailed photometry

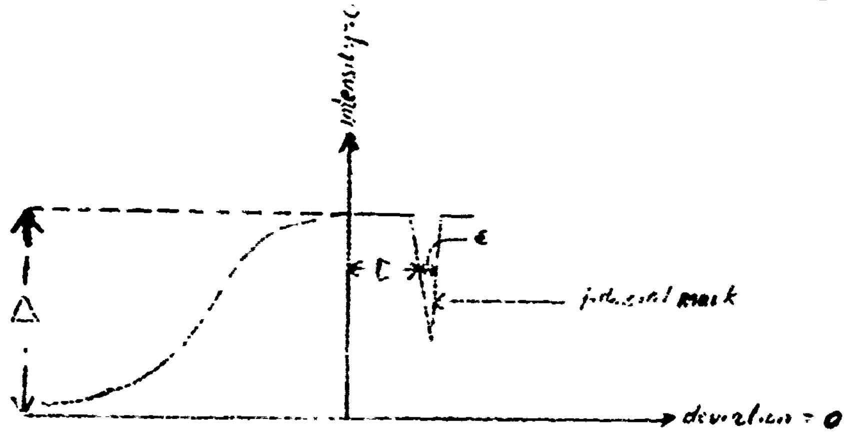
We have proceeded to a more detailed analysis of the spectra in order to examine the charactaristics of certain lines as a function of time. This study has necessitated a considerable amount of reduction work, which we have accomplished in two phases, as described below.

### A Reduction of the spectra to the form intensity vs. wavelength

The plates, as well as the corresponding calibration data, have been converted by means of the microphotometer so as to give a geometrical representation of the relative brightness of any given part of the spectrum. Corresponding to each spectrum we have thus a series of sensitivity curves, each of which gives the reaction of the plate over a range of approximately 100 Å. In order to reduce each spectrum to a physically meaningful form (intensity plotted against wavelength) we must first establish, for each wavelength region, a calibration curve relating the geometrical deviation from a predetermined zero to the physical intensity and, secondly, analyse each such wavelenght region of the spectrum in terms of the calibration curve thus obtained.

#### 1. Reduction of the calibration curves for each spectrum

These curves, such as they are recorded directly from the plates, give only the zero of the geometrical displacement. All other properties—maximum displacement, zero of the intensity—must be deduced from the fiducial mark, as indicated below, where $D = c\epsilon$ , c being a constant charactaristic of the plate.




The maximum displacement, $\Delta$ , is, by definition, that corresponding to the zero intensity (maximum darkness); and the relative intensity $\alpha$I, determined only to a multiplicative 'tant, is measured directly by the horizontal displacements

to the left of the origin. By calculating, for a series of intensity values, the corresponding vertical displacement as a function of the maximum deviation, $\Delta$ , we obtain the form most suitable for our purposes: a curve which gives, for each region of 100 Å, the logarithm of the relative intensity $\alpha I$ corresponding to a relative displacement $\delta$ .

2. Reduction of the spectra

The spectra are obtained from the microphotometer as a series of purely geometrical ordinates plotted against wavelength. It is therefore necessary to convert these ordinates into intensity values by means of the calibration curves corresponding, for a given spectrum, to the wavelength region in question. For this purpose, we must reduce each ordinate to a percentage of the characteristic deviation $\Delta$ contained between a maximum level indicated at the top of each recording and the zero level traced at the beginning and at the end of the spectrum. Generally speaking, this zero level remains constant, so that the quantity $\Delta$ is invariant over the entire spectrum. For the cases where the zero fluctuates, we have approximated it by a linear interpolation between its two extreme values, in such a way that the quantity $\Delta$ is a linear function of the wavelength. In such cases, therefore, each ordinate measured should be refered to a different value of $\Delta$ ; however, in order to simplify as much as possible a computation which is already extremely cumbersome (some of these spectra have necessitated the measurement and the computation of more than 800 points) we have introduced the approximation $\Delta$ = constant over a series of small intervals determined, in consideration of the zero level, so as to introduce an erreur of at most 5 % in the values of the quantity $\delta$.

Having thus obtained the percentage displacements for each centimeter of the recorded spectrum, we have only to compare them with the calibration curves corresponding to the wavelengths at which they are measured. We thus have a series of values $\alpha I$ corresponding to a series of wavelengths $\lambda$ . Since the charactaristics of the plates varie with the wavelength, we have had to smooth the intensity values corresponding to the wavelenghts situated at the junction of two calibration curves. This smoothing has been effectuated by measuring, for a given wavelength, the intensity given by each of the calibration curves which overlap there, and by calculating the resultant intensity as a weighted average of the two values thus obtained.

B. Determination of selected line profiles

Having reduced the spectra to the form intensity vs wavelength, we have proceeded to the analysis of individual line profiles, which we have determined as a function, in wavelength, of the line intensity related to the continuum intensity. Since we have no a priori criterium for establishing the continuum, our choice of a continuum is somewhat arbitrary and consists essentially in a geometrical enveloppe fitted to the spectrum in such a way as to coincide with it at the extremities of each line. As we are interested here in extremely fine details, we have calculated additional points in each line at intervals much smaller than 4 Å. The profile of any given line is then directly obtainable as the ratio, in function of the wavelength, of the line and continuum intensities (it is evident that the multiplicative constant associated with these intensities, being the same for both of them, drops out, leaving us with a direct measure of the intensity ratio $I_l/I_c$, which =1, by definition, at the extremities of the line). We have included in this report the sequence of profiles obtained for H$\delta$, one of the lines studied in detail. Other such sequences will appear in the printed form of this report to be published shortly in "Notes et informations de l'Observatoire de Paris". We remark that the values of the line intensity which lie in the non-linear regions of the calibration curves being somewhat less reliable than the others, we have indicated by a dotted line the sections of each profile corresponding to such line intensities.

Since the series of profiles obtained for any given line extends over several days, we have thus the possibility of studying in detail the evolution of these lines with the time. We expect to go into this question more deeply, but for the moment we limit our remarks to pointing out that the profiles of the lines hitherto studied manifest a sharp increase towards July 19.

We have also calculated for each date the equivalent width of the lines, defined as the width of a strip whose height, in units $I_l/I_c$, is unity, and whose area equals that of the line profile. The results of this calculation, for four of the lines which we have studied, are resumed in table I.

At present, we are in the process of extending our investigation to the rest of the broad emission lines as well as to some of the absorption lines.

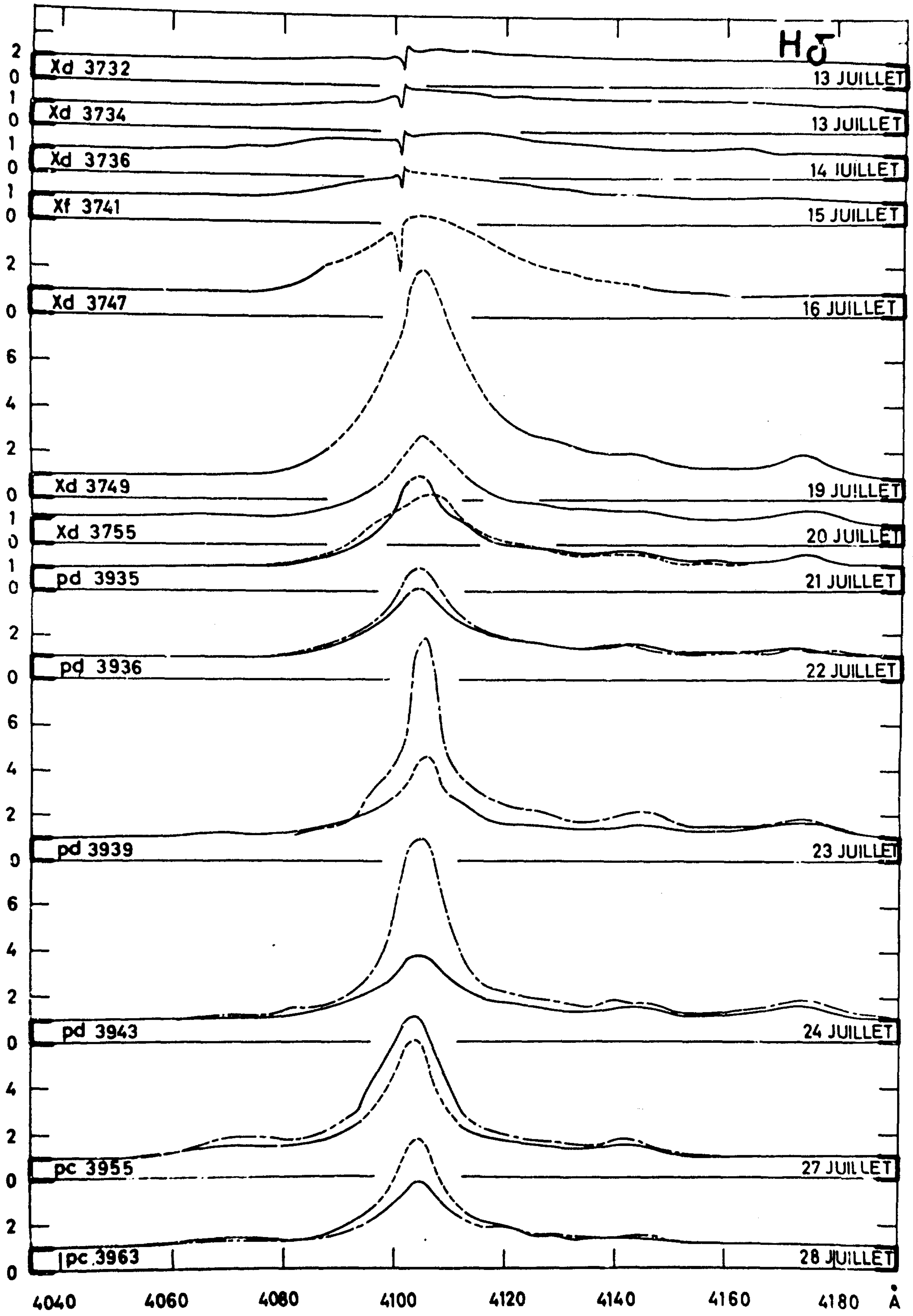
*Table I : equivalent widths*

| Plate No. / equivalent widths: | xd 3732 July 13 | xd 3734 July 13 | xd 3735 July. 14 | xd 3736 July .14 | xf 3740 July 15 | xf 3741 July 15 | xd 3745 July 16 |
|---|---|---|---|---|---|---|---|
| H $\alpha$ | | | 134,[illegible]5 Å | | 447,10 Å | | 348,86 Å |
| H $\beta$ | 34,39 Å | 37,99 Å | | 65,2[illegible] Å | | 79,20 Å | |
| H $\gamma$ | 24,72 Å | 35,02 Å | | 56,44 Å | | 63,86 Å | |
| H $\delta$ | 25,42 Å | 42,86 Å | | 51,53 Å | | 48,84 Å | |

| Plate No. / equivalent widths: | xd 3746 July 16 | xd 3747 July 16 | xd 3749 July 19 | xd 3750 July 19 | xd 3752 July 19 | xd 3755 July 20 | xd 3756 July 20 |
|---|---|---|---|---|---|---|---|
| H $\alpha$ | 371,75 Å | | | 320,55 Å | 219,80 Å | | 914,18 Å |
| H $\beta$ | | | 112,80 Å | | | 2[illegible]6,00 Å | |
| H $\gamma$ | | 116,6[illegible] Å | 215,06 Å | | | 217,12 Å | |
| H $\delta$ | | 114,01 Å | 222,40 Å | | | 125,07 Å | |

*Table I (continued) : the double entries correspond to those plates for which an over- and an underexposed spectrum exist*

| Plate No. / equivalent widths: | Pd 3935 July 21 | Pd 3936 July 22 | Pd 3939 July 23 | Pd 3942 July 24 | Pd 3943 July 2[illegible] | Pc 3955 July 27 | Pc 3963 July 28 |
|---|---|---|---|---|---|---|---|
| H α | | | | 1012,43 Å | | | |
| H β | 181,20 Å<br>171,60 Å | | 50,40 Å<br>131,60 Å | | 199,20 Å | 399,20 Å<br>186,00 Å | 320,40 Å<br>66,00 Å |
| H γ | 187,87 Å<br>146,67 Å | 81,16 Å<br>52,74 Å | 280,16 Å<br>152,25 Å | | 291,70 Å<br>140,49 Å | 94,76 Å<br>93,52 Å | 66,33 Å<br>176,34 Å |
| H δ | 92,31 Å<br>86,37 Å | 86,78 Å<br>73,59 Å | 158,10 Å<br>92,31 Å | | 162,08 Å<br>74,02 Å | 138,26 Å<br>96,99 Å | 77,85 Å<br>57,43 Å |



Hδ
Xd 3732
13 JUILLET
Xd 3734
13 JUILLET
Xd 3736
14 JUILLET
Xf 3741
15 JUILLET
Xd 3747
16 JUILLET
Xd 3749
19 JUILLET
Xd 3755
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pd 3935
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